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Effect of Standing to Improve Balance and Gait of Children with Cerebral Palsy

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ABSTRACT

The purpose of study is to describe the effects of standing to improve balance and gait of children with spastic diaplegic cerebral palsy (CP). The aim was to find out effects of standing to improve Balance and Gait.

Methods: - subjective prospective cross sectional quasi experimental flexible design was used. By using Convenient sampling method 30 numbers of spastic diaplesic cerebral palsy subject was selected in the study. Age group was 2 to 5 years; mean age 3.5 both the male and female. Screening was done by the screening tool Gross Motor Function Classification System (GMFCS). The outcome of Motor function was measured with the Gross Motor Function Measure (GMFM) and standing balance was measured by the instrument Pediatric Balance Scale (PBS). Intervention was done for 4 weeks 3 sessions per week 45 minute with wooden standing frame. Screened Child was placed in the Standing Unit in vertical or inclined plane depending on their functional abilities and Standing tolerance. Based on the statistic analysis software Statistical Package for the Social Science (SPSS-25) compare the effect pre test data by screening tool and the post test data out-come measure GMFM=0.00, PBS=0.00, paired t-test differences was GMFM pre-post and PBS pre-post - .00 and .05 respectively.

Conclusion:- On this study it is concluded that there is positive effect of prolong Standing to improve Balance and Gait. And it's also important to provide appropriate plane and positioning in the device for improvement. Hence these findings should be used in caution when treating the patients with Cerebral Palsy.

Keywords: *Cerebral palsy sensory, Gait, Balance, cognitive, and verbal impairment depression emotional behavioural problems mental retardation, seizure disorder, strabismus, and esotropia*

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INTRODUCTION

Cerebral Palsy is a tree like impairment having variety of functional involvement as motor impairment, physical dysfunction due to non-progressive involvement of the immature brain, damage that occur inside the utero, either perinatal or postnatal period of an infant, The brain damaged results in disorganized and delayed development of the neurological Mechanisms of postural control or Balance and movement[1].

Delayed motor milestone is a most consistent presenting feature of Cerebral Palsy as reported by Davis (1997). The complexity and extent of the difficulty not be fully realise until the child is 2-3 year old and sometime later[2]. Functional problem occur in performance component and performance context and as later the child get older, parents complain changes in deterioration in performance area. This condition clinically manifested through: abnormal muscle tone, lack of selective muscle control, dependence on primitive reflex patterns for ambulation, relative imbalance between muscle agonists and antagonists across joints, and deficient equilibrium reactions, the muscles activated for these motor aspects are therefore inefficient and in coordinated Individuals have hypertonic or hypotonic muscles with weakness[3]. Postural problem can be leads to the child becoming fearful to moving around. Some children have difficulty processing sensation from their muscle and joints find this difficulty locate their limb in relation to their bodies. Intellectual capacity as well as social skill are affected[4]. There may also have dyspraxia, some of them are also have visuo-motor deficits. These manifestations result in poor Gait and Balance in patient with Cerebral Palsy[5].

Disorders of the development of movement, postural control and Balance are the core features of Cerebral Palsy (CP) [6]. Increased muscle tone and poor selective control affect many children with CP and may contribute to decreased frequency and variety of voluntary movement (Wilson-Howle, 1999)[7]. Abnormal muscle tone interferes with function in children with CP (Gormley, 1999)[8] and may affect Gait by masking muscle strength, inhibiting generation of adequate muscle force, decreasing muscle flexibility, increasing energy consumption during walking, and altering Balance and the coordination between agonist and antagonist muscle groups [9,10].

Decreasing spasticity may enable the child to utilize their selective control more effectively and functionally (Flett, 2003)[11]. The reduction of spasticity may alter the constraints on ankle dorsiflexion during walking. Improvement in ankle kinematics during walking may allow the foot to accept weight during stance and allow proper foot positioning during stance thus allowing forward progression for efficient ambulation.

These problems can be minimized by prolonged Standing and used widely in clinical practice.

STANDING:

The children who stood unsupported – both the Typically Developing (TD) children and the children in CP fulfilled the requirements for postural orientation during Standing. They thereby had the ability to align and maintain their body position with respect to both gravity and the environment [12].

The basic function of maintaining a Standing position opposing gravity is derived from a complex interaction between both sensory and motor systems. For the motor task of Standing without support, posture and Balance – postural control – are central. Postural control involves controlling the body position in space for stability and orientation[13, 14].

The children's difficulties to stand still relative to gravity in CP, indicate proprioception disturbances with difficulties to sense movements of the limbs, both in and between the body segments, and the relative position of the body segments in space. Disturbed proprioception has been previously reported in children with CP in a study by Wingert et al. (2009)[14]. Moreover, Damiano et al. (2013) reported that proprioceptive deficits were related to instability in Standing and to decreased walking speed in children with mild CP, and Bartonek et al. (2016) suggested that disturbed sensory information from the lower limbs contributed to decreased walking velocity in children with CP.[17, 18]

Proprioceptive deficits including disturbances with both position sense and sense of limb movement in the lower limbs have been recognized in children with CP.[19, 20] Moreover, proprioceptive deficits have been related to instability during Standing in children with CP who could not stand unsupported.[21]

Locomotion is characterised by three essential requirements progression, postural control and adaptation. Progression is ensured through a basic locomotors pattern that produces and coordinates rhythmical patterns of muscle activation of the leg and trunk that successful moves the body in despaired direction. Postural control reflect the need to established and maintain an appropriate posture for locomotion, and for demand for the dynamic stability of the moving body.[24]

Prolonged Standing programs are used for children with Cerebral Palsy (CP) and have been shown to have wide-ranging positive effects in these children. Standing frames are recommended for children with limited mobility in the upright posture, including children with CP, to encourage proper alignment and weight bearing on the lower extremities (Gudjonsdottir& Mercer, 2002; Stuberg, 1992). Standing programs have been shown to increase range of motion (Baker, Cassidy, & Rone-Adams, 2007; Richardson, 1991; Tsai, Yeh, Chang,&Chen, 2001), improve muscle tone (Bohannon, 1993; Eng et al., 2001; Fefr, Fisher, & Langbein, 1994, 1996; Odeen & Knutson, 1981; Pin, 2007; Shields & Dudley-Javoroski, 2005; Tremblay, Malouin, Richards, & Dumas, 1990; Tsai et al., 2001), improve bone growth, and increase bone mineral density (Caulton et al., 2004; Gudjonsdottir & Mercer, 2002; Gudjonsdottir & Stemmons, 1997; Stuberg, 1992; Wilmshurst, Ward, Adams, Langton, & Mughal, 1996), and are assumed to prevent or reduce secondary impairments by maintaining muscle extensibility, preventing muscle and soft tissue contracture, and promoting optimal musculoskeletal development (Stuberg, 1992).[27]

Despite widespread use, the clinical effectiveness of supported Standing in improving Gait measures in children with CP has yet to be established. The purpose of this study was to determine the effects of prolonged Standing to improve Balance and Gait of the children with spastic diplegic Cerebral Palsy. There is paucity of study on Standing and Gait.

Therefore attempt has been taken to known the effect of prolong Standing to improve Balance and Gait.Therefore intent of the study is to understand the effects of standing to improve Balance and Gait for children with Cerebral Palsy.

AIMS OF STUDY:

Find out effects of standing to improve Balance and Gait.

HYPOTHESIS:

There is a positive effect of standing to improve Balance and Gait

NULLHYPOTHESIS:

There is no effects on the Standing to improve Balance and Gait.

METHODOLOGY

Design:

A different subjective prospective cross sectional quasi experimental flexible design was used for proposes of the study this deal with the details description of the subject. Design of the study is A-B-A.

Subject:

Convenience sampling was used. Total 30 numbers of subjects with spastic diaplesic Cerebral Palsy were selected for the experiment. Age group was 2- 5 years; mean age 3.5 both the male and female. All subjects were selected from the pediatric section of department of occupational therapy SVNIRTAR, Cuttack over the period of one year. All the subjects were diagnosed spastic CP and all were routinely tested during the initial assessment. Those who were participated in the study had followed the instruction adequately. And they were granted inform consent before testing.

Inclusion criteria:

- Subject was diagnosed as spastic diplegic CP.
- Age group was 2 to 5 years.
- Both male and female were included.
- Ability to follow the command
- Gross motor Function Classification System (GMFCS) level- 2 to3

- MAS grade 1 or 2.

Exclusion Criteria:

- Children with Mental retardation were excluded.
- Cerebral Palsy with mental retardation also excluded.
- Acute orthopaedic disorder.
- Post operative condition.
- Any contracture or deformity.

INSTRUMENTATION:

Screening Tool:

Gross Motor Function Classification System (GMFCS): This Scale is now widely used to classify the Gross Motor Function of children with Cerebral Palsy. It is an instrument which gives information about prognosis of children with CP. This gives out comes of motor disability of infant in large population.

GMFCS is five level scale that rates the Childs Gross Motor Function which emphasises movement initiation for Standing Balance and Gait. Level -1 includes Walking without Limitation and level -5 is Transport on Manual Wheel Chair depends on the age in the form of Birthday [75] (APPENDIX-III).

Out Come Measure:

1. **Gross Motor Function Measure** (GMFM); - the scale was developed for Evaluation and Assessment of motor function in child with CP and by using this measure we can observe motor behaviour by a standard score. It is last type measure that required evaluating the effectiveness motor intervention for children with CP. It is consist of 88 item grouped in five dimensions lying & rolling, sitting, crawling & kneeling, Standing, running and jumping. The item score on 4 point ordinal scale, score for each dimension expressed as percentage of the maximum sore for that dimension. Total score is obtained by adding the percentage score for dimension and dividing by 5 from which I took only D and E which is standing and running & jumping. And score was like adding by both the scale divided by 2 which is goal total score age group is 5 to 16 year[76] (APPENDIX- IV).
2. **Paediatric Balance Scale** (PBS);- The instrument use for measure for school age children with mild to moderate motor impairment scale having 14 item which should be scored utilizing 0 to 4 scale. If the first trail a child receives the maximal score of 4. Age group is school age like 2 to 14 maximum score is 56 [77] (APPENDIX- V).

INTERVENTION

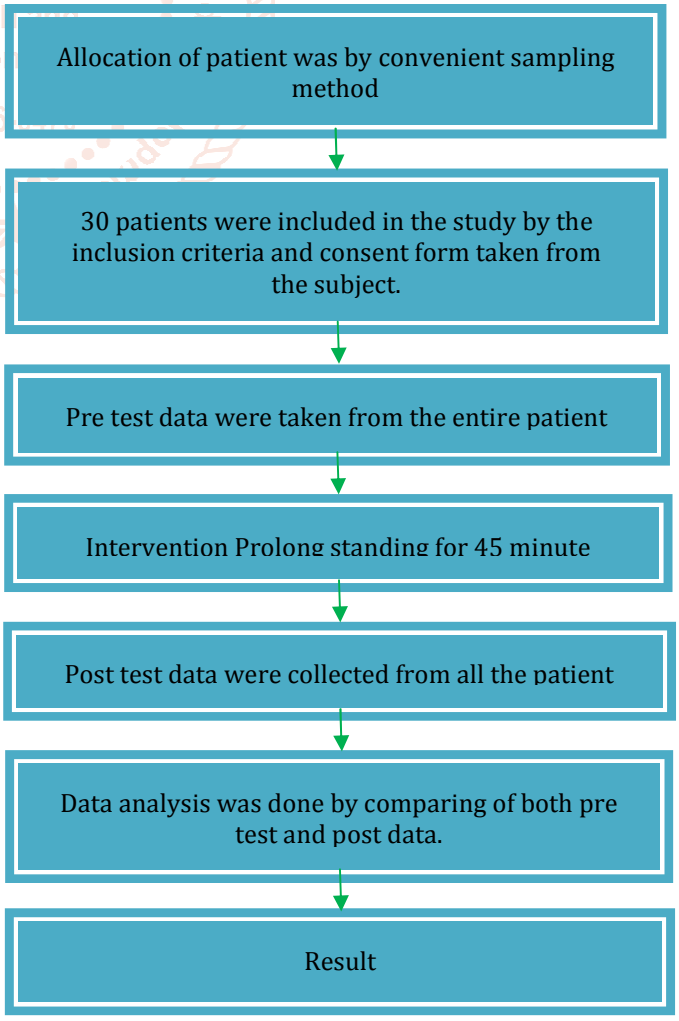
The entire subject undergone a therapeutic intervention aimed was to increase Postural control on static Balance and Gait. Therapy was done for 4 weeks 3 sessions per week 45 minute duration by screening tool (GMFCS) and inclusion and exclusion criteria had been screened out the subject for therapy. After the intervention subject was measure the through outcome measure PBS & GMFM to check out the improvement.

Standing unit:

The screened Child was placed in the Standing Unit in vertical or inclined plane depending on their functional abilities and Standing tolerance. Straps (2 inch) were attached around pelvis to stabilise and maintain the pelvic in straight. 2 inch straps also was used around hip that is mid thigh to prevent sway and hip flexion. It gives stabilization to the hip joint and ankle to prevent involuntary movement. Also it makes the lower extremity straight for proper weight bear on lower limb to maintain the normal anatomical position as much as possible. Different size straps were used for Hip and Ankle to prevent involuntary movement. Child was encouraged to play or leisure time activity by using upper extremity while Standing. Activity like Peg Boards, Rings, and Blocks were used while reaching out forward, upward, and sideways unilaterally/bilaterally for weight shifting on foot alternatively. Allowed and encouraged the child to stand around 45 minutes in the Standing unit maintaining the body in proper anatomical position by using toys as per their likes and interest.

PROCEDURE

FLOW CHART



DATA ANALYSIS

Total 30 number of subject was selected for the study from the age group 2 to 5 with the mean age of ± 3.3were taken in to analysis.

The SPSS 25 software was used for analysis the data. Subject was being assessed before the intervention and two outcome measure instrument namely GMFM, PBS were used. Each assessment was followed by reassessment by the same investigator.

The GMFM pre test was compared with the post test by Wilcoxon Signed Ranks Test for the significant difference in mean scores. (Table-1)

The pre test data of PBS was compare with the post test data by the test Wilcoxon Signed Ranks test for the significant difference in mean score. (table-2)

The pair (T) test was used to compare the GMFM pre test-post test and PBS pre test – post test the test value was significant. (Table-3)

Finally the GMFM post test was compare with the PBS post test score there is significant difference between the scores. (Table-4)

DATA TABLE

TABLE-1
WILCOXON SIGNED RANKS TEST

	N=30						
	PRE- TEST			POST-TEST			SIG. VALUE
GMFM	MEAN	STD.DEVIATION	STD.ERROR MEAN	MEAN	STD.DEVIATION	STD.ERROR MEAN	0.00*
	6.46	5.69	1.03	29.53	20.52	3.74	

TABLE-2
PBS PRE TEST AND POST TEST
PAIRED SAMPLE T TEST

	N=30						
	PRE- TEST			POST-TEST			SIG. VALUE
PBS	MEAN	STD.DEVIATION	STD.ERROR MEAN	MEAN	STD.DEVIATION	STD.ERROR MEAN	0.005*
	4.70	2.23	0.40	17.40	9.24	1.68	

* INDICATE SIGNIFICANCE VALUE <.05

TABLE-3
PAIRED T-TEST
PAIRED DIFFERENCES

		MEAN	STD. DEVIATION	STD.ERROR MEAN	df	Z	SIG
PAIR 1	GMFM PRE-POST	-23.07	16.87	3.08	29	-4.782	.00*
PAIR2	PBS PRE-POST	-12.70	8.36	1.52	29	-4.785	.05*

* INDICATE SIGNIFICANCE VALUE <.05

TABLE- 4
PAIRED SAMPLE STATISTICS

		N	MEAN	STD.DEVIATION	STD.ERROR
PAIR 1	GMFM POST	30	29.53	20.52	3.74
PAIR2	PBS POST	30	17.40	9.24	1.68

RESULT

The table -1 shows the descriptive statistic, the Range for GMFM-88 with the pre test mean score 6.46, standard deviation 5.69, std. error 1.03, post test mean score was mean value 29.33, std. deviation 20.52 and std. error 3.74. The range of pre test PBS score was like mean 4.70, std. deviation 2.23, std. error 0.40 post test mean score 17.40, std. deviation 9.24 and std. error 1.68 in (table-2), line graph 2 (A) and column graph 2(B).

There is significant difference between pre test and post test of GMFM with significance of p=0.00 in (table-1), line graph 1 (A) and column graph 1(B) When both pre test and post test data was compare there is a significant difference found among the scores.

There is significance difference in PBS first and final evaluation in (table-2), line graph 2 (A) and column graph 2(B) with the p=0.005. When both pre test and post test data was compare there is a significant difference found among the score.

There is significant between the GMFM and PBS both pre test and post test (table -3) mean score of GMFM 23.07, 12.70, std. deviation 16.87,8.36, std. error- 3.08,1.52, Z value -4.752,-4.785, p=0.00,0.005 respectively. When both are compare there is significant score found and shows in the line graph 3 (A) and column graph 3(B).

When compare post test of GMFM and PBS(table-4)there is difference in mean score of GMFM 29.53 and PBS 17.40, standard deviation 20.52, 09.24, sdt. Error 3.74,1.68 respectivly difference was found within the group and also shows in line graph 4 (A) and column graph 4 (B).

DISCUSSION

The purpose of this study was to determine the effects of Standing on Gait and Balance in children with CP. Improvement was shown In this current study 1- On the floor pull to stand on large bench, 2- stand: maintains arms free 3 seconds, 3-stand: holding on to large bench with one hand lifts right foot, 3 seconds, 4- stand: holding on to large bench with one hand lifts left foot 3 seconds, 5- stand maintain arm free for 20 second, 6-sit on small bench: attains stand without using arms, 7-stand 2 hands held: walks forward 10 steps, 8-stand 1 hand held: walks forward 10 steps, 9-stand: walks forward 10 steps of in the GMFM. Result show with p= .00 are improve significantly. There were significant changes in between the pre test and post test score, significant changes in the item no. Sitting to Standing, Standing to sitting "Sit down slowly without using your hands", Transfers, Standing unsupported, Sitting unsupported "Sit with your arms folded on your chest for 30 seconds", Standing with feet together, Standing with one foot in front, Standing on one foot, of PBS all items respectively with p=0.005.

Item no. 1: on the floor: pulls to stand at large bench Sitting to Standing which normally involved extension of the lower limbs over a fixed base (on the feet) may be impossible without extensive use of upper limb. The diplegic child may be pull to stand with feet placed too far forward and planter flexed. So as a result body mass is too far behind the base of support and upper limb gross movement of hand help to pull to get up and stand. Children underwent a specially designed program for core stability, as the core muscles are important for moving in and out Standing position in children with CP. Similarly, Dodd et al.(2002) reported that the core muscles stabilize the central part of the body to allow controlled movements of the upper and lower limbs. Thus, the core stability program may be modified to enhance Balance in children with CP [78].

Item no.2: Standing maintains, arms free 3 seconds; Before intervention child was unable to maintain the unsupported Standing position or Balance after weight bearing the both group muscle agonist and antagonist worked symontaneouly to maintain co contraction for smooth movement. The results of the current study were reinforced by Gillen, (2013) who concluded that children with spastic CP have defects in the timing of motor responses. To support surface perturbations, such as delayed muscle activation onset, which moves the centre of mass towards the limit of stability and leads to more proximal muscle activation before distal muscle activation when responding to support surface perturbations in the Standing position which is the opposite to that observed in children with normal control. Finally children with spasticity have postural adjustment deficits associated with voluntary control in static and dynamic activities. There was a significant improvement in Balance [79].

Item no.3: Holding one hand one leg Standing while child wants to stand on one leg that means when he/ she will lift her one leg, spastic diplegic subject normally unable to maintain or difficult to maintain the position because of narrow base of. support. To maintain the Balance on one leg subject has to shift the body weight left/ right for better control of Balance. When body weight had change position the subject has to maintain the COG. Hessari et al. (2011) who had reported that core stabilization training improved the dynamic Balance in CP with mental retardation [81]. Limb protraction/retraction control was found to be dominant during medial-lateral sway, whereas the estimated body transverse rotation contribution was significant for anterior-posterior Balance. These are significance of body transverse rotation control contribution in unsupported Standing[82].

Item no.4: stand: holding on to large bench with one hand lifts right foot 3 seconds:- subject stand on one leg with the holding of one hand to the large bench, the base of support is decrease but shifting of body weight properly will help the child to maintain the Balance with narrow base of support. By holding the large bench will help the child to maintain the Balance and the CG will passes through the hip and knee joint of left to maintain the Balance. Hyper tonicity of extensor synergy may interfere hip flexion, abduction and dorsi flexion of foot. Children with CP cannot allocate their body weight during static Balance and shift the body weight from one limb to another during dynamic Balance [82]. Supported by the Sterba et al.(2002), who had reported that postural and equilibrium reactions in children with CP could be improved by strengthening the core muscles in addition to achievement of joint stability, co-contraction, and mproved ability to shift weight [83].

Item no.5: stand: holding on to large bench with one hand lifts left foot, 3 seconds as correlate in the study were supported by the studies mentioned on item no 4.

Item no.6 : sit on small bench: attains stand without using arms from sitting position to Standing on a small bench need to use the co contraction of both agonist and antagonist muscle of hip joint because during sitting to Standing isotonic contraction of quadriceps and isometric contraction of hamstring as a result smooth and coordinated movement is possible. Baker MJ (1993) and Wilson (1997) studied on sitting to stand Behaviour with Orthosis in CP children and they found that orthosis improved upright trunk posture which further confirms the co-activation of antagonist which interfere the normal function Baker MJ 1993 SKH).

Item no.7: stand 2 hands on large bench: carries 5 steps to right, stability is characterised by the ability to maintain the stable posture. Children who demonstrate problem in stability may be unable to hold the steady because of increase tone O Sullivan (2001). Walk with less base of support and less stability which is difficult for the CP with spasticity**.** Mostafa S. Ali (2019) enabling smooth decided movements and to improved upper- and lower-limb muscle strength, which affects the spine through the length tension relationship [84].

Item no.8: stand 1 hand held: walks forward 10 steps:- According to the motor control child having problem in continuous movement subject are unable to walk. Gentile in 1987 state that the weather the base of support is steady or moving depends on that he conclude that base of support is steady Stability is more and viscera like mobility task such as walking stability requirement less demanding so for Balance and to compromise fulfil his demand of stability child use one hand held. The Core stability program improved Balance as a result of better modification of load transfer and efficient patterns of weight distribution [87]. Thus core exercises could improve Balance in our children with CP.

Item no.9: stand: walks forward 10 steps:- inter-limb coordination along with walking, these results are reflective of improvements in Gait pattern efficiency. The Iimprovements in postural control and floor mobility is reflects an increase in symmetry between right and left step or stride lengths. Indicative of an increase in consistency in measured Gait parameters. Denise M. Begnoche (2007) says that it may also reflect improvements in dynamic postural control during Gait . Although group significance was not shown, all participants exhibited increases in speed of walking [88]. Proprioceptive reflex and counteract the sensation of pain [89]. The Weight bearing exercise is enhanced neuromuscular activation [90]. Weight bearing exercise is affects muscle strength and increases the power to improve Balance [91].

Paediatric Balance test was used to assess the Balance. The standardized examination tool currently utilized by paediatric physical therapist and Occupational Therapist for school age children with mild – moderate motor impairment include Brouninsk's Oseretsky test of motor proficiency, Burn (1978). The pea body Development motor scale (Folio) Gross Motor Functional measure, Rusell (1993). In addition clinicians have developed their own Non standardized measure, Wescott (1995). The standardized and non standardized measure that currently provide clinicians with valuable information but may not fully meet their need to asses a Childs functional Balance ability is high base on pediatric Balance scale has been selected.

Gross Motor Function Classification System was used to classify the CP children. Methods of classification that had been proposed are base on (1) pathophysiology (or) neuroanatomical location of the lesion. Fay 1950) Perstein (1952), Minear (1950) (3) part of body must involved, Balf & Ingram (1995) Menear (1956), (4) Ambulatory Status Badell- Rebera (1985), Yoaochi et al (1993).

These methods of classification rely heavily on clinical judgement and are primarily of a value for diagnosis. Their reliability and validity have not been investigated. Base on GMCS scale subject was selected. The reliability validity has been studied by Ellen Wood (2000) and Amy Winter Bakin (2003). They found that the GMFCS has very high reliability and validity.

Modified Ashworth Scale was being used for selecting the subject for assessing the muscle tone as muscle tone is velocity dependent but it was not use in the statistically only for the assessment it had been used. The reliability validity of modified ashworth scale is yet it is not confirm. By that assessment investigator found that there is a changes in the muscle tone before the intervention and after the intervention. Nancy Clopton, et al (2005) concludes that as appropriate reliability for clinical use. And no evidence was found that training improves reliability [92] And also Akmer Mutlu state that These scale is not very reliable and assessments of spasticity using these scales should be therefore interpreted with great caution [93].

CONCLUSION

On this study it is concluded that there is positive effect of prolong Standing to improve Balance and Gait. And it is also important to provide appropriate positioning device to improve Gait and Balance. Hence these findings should be used in caution when treating the patients with Cerebral Palsy.

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